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AIRCREW CRITIQUE OF HIGH-G CENTRIFUGE TRAINING: PART I: "WHAT WAS THE BEST PART OF THE PROGRAM?"

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We have successfully initiated a fighter-attack aviator high-G centrifuge training program at the Naval Air Development Center. This report reviews the critiques of 515 of 525 aircrew who participated in the centrifuge training. We received no negative overall critiques from USN, USMC, or USAF aircrew. Of particular note was the favorable aircrew attitude toward the "HOOK maneuver" as the preferred method for teaching and performing the anti-G straining maneuver, and aircrew agreement that a G-LOC exposure would be a very beneficial part of the training program. A multitude of additional suggestions by the fighter aircrews offer the potential for further enhancement of an extremely successful program. The centrifuge training program has the potential for making the most significant enhancement of the interface between the fighter aviation medicine/aerospace physiology programs and fighter-attack operations that has yet to exist. The centrifuge training program not only enhances flight safety it also can immediately improve the combat capability of fighter-attack aircrew.

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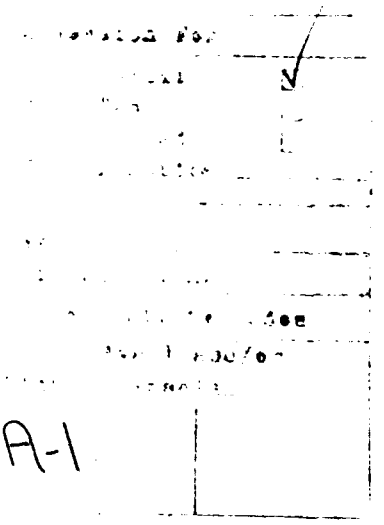
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INTRODUCTION

The Naval Air Development Center (NADC) initiated centrifuge high-G training for naval aviators assigned to fighter-attack aircraft late in 1988. The program was essentially identical to the program developed for training USAF Tactical Air Command aircrew as previously described[1]. The techniques and training objectives were the same with the following exceptions: (1) Electrocardiographic (ECG) monitoring was required of all naval aircrew trainees, (2) An individual aeromedical specialist (coach) was assigned to each trainee to personally work with them before, during, and through the videotape debriefing following each trainees centrifuge runs to provide maximum personal attention and optimize the performance of the anti-G straining maneuver (AGSM), (3) We emphasized the "HOOK"" maneuver as the method of AGSM performance[2], and (4) All pertinent information (including ECG and anti-G suit pressure tracing) was concentrated on the trainees videotape[3]. The human centrifuge/dynamic flight simulator of NADC was utilized for the training. It has a 50 foot radius and a dual gimbal configuration. We have previously described the general results of the aircrew training[4]. This report reviews the fighter aircrew critique of the high-G training program. The objectives of critique review include: (1) Continuous course content modification to better suit the needs of all trainees including naval fighter-attack aircrew, and (2) Development of optimum techniques that will carry over and be applicable to operational flight for enhanced aircrew performance and improved mission accomplishment.

AIRCREW CRITIQUE

The questionnaire (Appendix I) that was implemented with the initiation of aircrew training was designed to provide aircrew with open-ended feedback to anonymously express their thoughts and opinions on the centrifuge training. As such, it does not lend itself well to definitive statistical analysis. Our major interests were associated with aircrew opinion concerning the acceptability of the training and their input relative to how they would change the program to better suit their operational needs. The

questionnaire was completely anonymous, however, many aircrew were eager to identify themselves and desired to have continued feedback on various aspects of the program. It was accomplished by aircrew following completion of the training.

Based on the responses provided, we have broken down the information into 3 sets of data which covered: (1) the G-awareness briefing, (2) the best aspects of the training, and (3) the changes that would be recommended. Each of these areas will be discussed individually. This report covers only what aircrew considered the best aspects of the training program. The responses included in Appendix II were not all inclusive from the 525 aircrew who completed the critiques. Only 10 aircrew failed to complete critiques; this was due to an early departure from the training prompted by awaiting naval air transportation. Only responses which contained information that could be of use to further our efforts to serve fighter aircrew through enhanced training are included in this report. Although we were very gratified by the too numerous to count favorable expletives provided by the aircrew (such as fantastic, super, outstanding, excellent, good, and superb) we have not included these in Appendix II when they were given alone. The data must be viewed with the knowledge that we received no overall negative critique from any USN, USMC, or USAF aircrewman.

WHAT WAS THE BEST PART OF G-TIP?

The information included in Appendix II was taken from the specific question "What was the best part of G-TIP?" and from the general question asking for "Comments on the centrifuge training." The responses could be roughly grouped into 4 major categories of what aircrew found most beneficial, as shown in Table I. The following discussion covers the responses in Appendix II.

We were extremely encouraged by responses such as comment number 5 from a 32 year old F-16 pilot: "Best training I've ever had! Will increase my ability to kill enemies of the U.S. I can use my

aircraft capability fully now!"; comment number 42 from a 41 year old F-18 pilot: "Best, most worthwhile aviation physiology training I've had in 20 years, a must for TACAIR"; comment number 81 from a 27 year old F/A-18 pilot: "The centrifuge is an awesome tool for training. It sure beats the heck out of learning about G-LOC on the low altitude training route or in an ACM engagement! It's an absolute must for all high performance aircraft pilots"; comment number 216 from a 29 year old AV-8B pilot: "Best training program I've experienced in my flying career"; and comment number 301 from a 30 year old A-10 pilot: "You're saving lives, money, and aircraft. Best example of joint service cooperation in existence." It is a distinct privilege in fighter aviation medicine to be in a position to directly support fighter aircrew in their operational mission.

Almost every aspect of the program was mentioned at least once by aircrew as their most favored part of the training program. We feel that all the program components are indispensable and together represent a powerful combination, as reflected in comment number 291 from a 23 year old F-14 NFO: "All of it", and comment number 292 from a 34 year old F-4 WSO: "Everything together."

It is important to evaluate the more specific parts of the training program in an effort to enhance the program for fighter-attack aircrew. The two major facets of the program, by design, were to enhance the G-awareness of the fighter aircrew and to ensure that aircrew can protect themselves from the adverse effects of $+G_z$ stress (including $+G_z$ induced loss of consciousness (G-LOC)) by performing an optimal anti-G straining maneuver (AGSM). This emphasis is apparent from the comments of the aircrew. It is also evident that these goals were successfully met as reflected in comment number 36 from a 38 year old F-16N pilot: "Lecture was great but even better was the actual run in the centrifuge. An invaluable learning experience! Not to be missed by Aerospace Athletes"; comment number 185 from a 34 year old F-16N/A-4 pilot: "The lecture combined with the ride. The lecture in itself is outstanding, but the combination of the two is unbeatable"; comment number 192 from a 30 year old F/A-18 pilot: "Lecture and ride - I never knew how incorrectly I was doing my straining maneuver until

I had to do it!"; and comment number 233 from a 29 year old AV-8B pilot: "Combination of briefing, AGSM practice, centrifuge rides, and debriefing is unbeatable." The G-awareness briefing will be discussed by itself in a later report. At least one aviator expressed favor with each of the individual centrifuge profiles. It was clear that the first profile, a gradual onset run (GOR), was considered by many individuals to be extremely valuable as evidenced by comment number 92 from a 24 year old AV-8B pilot: "The first ride to test G-tolerance threshold"; comment number 142 from a 26 year old F-14 pilot: "I particularly liked the first run, which demonstrated the effectiveness of the AGSM"; comment number 226 from a 29 year old F-14A+ pilot: "The experience of checking your limits and 'slowing' getting some visual loss was very instructive"; and comment number 39 from a 26 year old F-14 NFO (non-flying officer): "Gradual onset with no G-suit to show limits." Many aviators clearly considered knowing what their tolerance was and where their limits were as extremely important. We had been concerned about the aviators possibly complaining about the high-G levels of exposure ($+8G_z$ and $+9G_z$), especially those flying A-7, AV-8B, and F-14 aircraft where the operational $+G_z$ envelope is well below these levels. This was not, however, a major concern of the aviators as voiced by comment number 302 from a 25 year old F-14 pilot: "In my opinion it is a good experience for pilots to experience higher G than they are used to experiencing"; comment number 27 from a 31 year old F-16/A-4 pilot: "This is the place to pull 9 G's for 15 seconds and not in a jet for the first time. Being an adversary pilot flying F-16N's I may find myself in a situation like this and having seen the sustained G loads in the centrifuge is invaluable"; comment number 35 from a 28 year old A-4/F-16 pilot: "The high G profiles 8-9 G's. Great hands on experiences"; and comment number 103 from a 37 year old A-7E pilot: "On the first 9 G run my vision started to go so I hooked harder and got it back - GOOD TRAINING!" All these comments attest to the acceptance of the current training profiles.

Just as we had hoped, aircrew strongly concurred with the value of the centrifuge training to enhance their capability and understanding of performing an optimum AGSM: comment number 13 from a 39 year old F-15 pilot: "This is the first time in 17 years of flying fighters I've correctly performed

the AGSM"; comment number 37 from a 48 year old F-5 pilot: "Seeing my mistakes - I've been doing it wrong! Very impressed - you are directly enhancing our safety"; comment number 47 from a 26 year old F-14 pilot: "Definitely, I now know how to fight G-LOC; I'm confident of my abilities now"; comment number 75 from a 30 year old F/A-18 pilot: "Outstanding!! The only real opportunity to see the effectiveness of the AGSM. Well worth the effort!"; comment number 104 from a 37 year old A-7E pilot: "I didn't know how to do the AGSM in spite of previous physiologic training courses. I know now!!!"; comment number 197 from a 28 year old F-14A pilot: "Excellent - improved my AGSM and made me realize that I wasn't using my legs. 9 G's was easier than 8 G's when I strained them also"; and comment number 249 from a 26 year old F/A-18 pilot: "Definitely worth the time - I have been using completely wrong techniques before." Although we do not insist that there is only a single technique for performing an effective AGSM, we are convinced of the exceptional value of using the "HOOK" maneuver in centrifuge training[2]. It facilitates teaching AGSM principles, it's easy to demonstrate, is easily remembered by aircrew, and enhances the ability of coaches to critique trainees. Of extreme importance is the ability to correct poor AGSM performance in the midst of a short 10 to 15 second $+8G_z$ or $+9G_z$ run with the AGSM coach exclaiming "Just say HOOK!" By saying "HOOK" the proper emphasis on completely closing the glottis is easily facilitated. There is barely time for any other comment. We strongly believe that trying to name the AGSM with terms such as M-1 or L-1 is confusing. The "HOOK" maneuver is just what it "says". The trainees strongly concurred with the value of the "HOOK" maneuver: comment number 54 from a 25 year old F-18 pilot: "Extremely useful training - emphasis on the 'HOOK'"; comment number 85 from a 41 year old A-37 pilot: "'HOOK' much, much better than old "grunt" we were taught"; comment number 140 from a 29 year old F-14 pilot: "Getting to do the hook and see the results"; comment number 188 from a 25 year old F/A-18 pilot: "'HOOK' method and it worked great"; comment number 220 from a 39 year old F-4E pilot: "I finally know how to do a good AGSM (after 14 years of flying jets)!"; comment number 266 from a 42 year old F-16 pilot: "The word and procedure - HOOK!"; and comment number 278 from a 25 year old F/A-18 pilot: "Helped me do an AGSM a hundred times better, the 'HOOK'!" We therefore feel the "HOOK" maneuver

has many benefits as listed in Table II which includes proven effectiveness and a high level of fighter aircrew acceptability.

The centrifuge training was definitely considered a confidence builder: comment number 11 from a 27 year old RIO (radar intercept officer): "Feeling 9 G's and knowing you can hack it"; comment number 43 from a 33 year old F-18 pilot: "Confidence about personal limits"; comment number 119 from a 32 year old F/A-18 pilot: "Confidence builder. I had felt intimidated since I had never pulled 9 G's before"; comment number 12 from a 28 year old F-14 RIO: "I was always under the impression that once you started to grey out that you could not regain vision without easing the G. Now I know that if I 'HOOK' harder I can push it back"; comment number 57 from a 24 year old F-18 pilot: "This training will give me more confidence to fly aggressively and safely"; comment number 286 from a 48 year old A-7 pilot: "Very important for pilots to experience 'high' G in this controlled environment. Also, it's a confidence builder"; and comment number 155 from a 40 year old F-16 pilot: "Now I know I can do it if I have to."

Recent disclosures concerning centrifuge training conducted in the Union of Soviet Socialist Republics reveal that G-LOC training is a valued part of their program[10]. The G-LOC training is considered to be a key reason for the reduced problems with G-LOC in the Soviet SU-27 and MiG-29 fighter aircraft. We have previously described the benefits of "G-LOC training" including enhancing the recognition of in-flight G-LOC and reducing the duration of G-LOC incapacitation should it occur[5]. It is evident that numerous fighter aircrew concur with these ideas involving G-LOC training: comment number 49 from a 31 year old A-4/F-16 pilot: "Losing consciousness and not knowing it. Too bad you can't take every aviator to G-LOC"; comment number 71 from a 26 year old F-14 pilot: "G-LOC should be experienced by everyone"; comment number 91 from a 26 year old AV-8B pilot: "Just outstanding for helping pilots avoid G-LOC. I will now be able to recognize/avoid G-LOC (I G-LOC'd once)"; comment number 84 from a 27 year old F/A-18 pilot: "Really good! It taught me to be careful with the

'I can hack it' attitude, plus how to recognize a G-LOC that's coming on (I had 2 G-LOC's). Keep doing business like you are, I'm a happy customer"; comment number 281 from a 43 year old F-15 pilot: "Actual G-LOC training would be superb - could save lives"; comment number 282 from a 26 year old F-14 RIO: "Blackening out completely with G-LOC (though embarrassing) was a good learning experience"; and comment number 280 from a 41 year old A-7 pilot: "Experiencing loss of consciousness helps give appreciation of importance of entire G-TIP Program." These comments, along with those in the recommendations for changes in the program, which will be covered in a separate report, strongly suggest that at least an optional opportunity to experience G-LOC during the centrifuge training would be both beneficial and acceptable to fighter aircrew.

The importance of the ancillary aspects of the centrifuge training cannot be over-emphasized. Confirmation of the importance of the opportunity to watch others during the training was evident: comment number 96 from a 27 year old F-18 pilot: "Being able to see other people in the group helps you get it right"; comment number 144 from a 28 year old A-4/F-16 pilot: "Eye opening. Got as much watching others after finishing myself"; and comment number 165 from a 24 year old F-14 pilot: "The ride in the ball and watching others learn to hook correctly." The videotape debriefing with their individual coach was a highly valued program aspect: comment number 111 from a 24 year old F-14 pilot: "The debrief - seeing my own traces and realizing my mistakes"; comment number 277 from a 32 year old F/A-18 pilot: "One-on-one debrief post training"; and comment number 69 from a 25 year old F-14 pilot: "The debrief of the run - you can see your results." Individual assignment of an AGSM coach to each aircrew was a valuable program aspect: comment number 53 from a 31 year old F-16/A-4 pilot: "The 1 on 1 continual feedback during the centrifuge training. Super personnel!"; comment number 93 from a 28 year old F-18 pilot: "The coaches and debrief"; comment number 194 from a 39 year old A-4/F-16 pilot: "Experienced observers critiquing and improving my G-straining technique in an academic environment"; and comment number 199 from a 27 year old F/A-18 pilot: "Great! Coaching the HOOK maneuver BEFORE, DURING and AFTER."

The aircrew sensed the importance of the personnel responsible for their training with credibility being put at a premium: comment number 95 from a 24 year old F/A-18 pilot: "The personnel running the program are the best part. Medicine and physiology are actually (real) helpful." It was important for the aircrew to sense they were in a safe environment for the high-G exposure: comment number 270 from a 31 year old F/A-18 pilot: "It provided a chance to actually perform and experience high-G in a controlled environment", and comment number 105 from a 41 year old F/A-18 pilot: "Doing it in a benign environment. Not particularly fun, but outstanding, valuable training."

We required electrocardiographic (ECG) monitoring for all naval aviators and not a single aviator questioned the procedure. Many aircrew eagerly wanted to review their ECG responses and some even considered it the best part of the program: comment number 97 from a 38 year old A-7E pilot: "Centrifuge ride, medical recording, and videotape debrief were the most valuable part of the training"; and comment number 202 from a 26 year old F-14A RIO: "Opportunity to experience G in a controlled, monitored environment." The ECG monitoring is invaluable in assuring both training safety and normal $+G_z$ cardiovascular tolerance[11,12,13]. We have successfully overcome the reservations concerning ECG monitoring that existed in the initial training for USAF aircrew and totally concur with the recommendation for such monitoring as described by Gillingham[1].

Many aircrew had specific comments on exactly when the training should be given and the need for recurrency of the centrifuge training. Naval aircrew were much more likely to recommend recurrent centrifuge training than their USAF counterparts: comment number 14 from a 26 year old F-14 pilot: "Fantastic program. We need a centrifuge at every base for constant use by aircrew. This training is a must on a regular basis"; comment number 72 from a 43 year old F-4E pilot: "Make training an annual or semiannual requirement"; comment number 115 from a 38 year old A-7E pilot: "This training should be completed at least as often as physiology/swimming training (every 4 years currently)"; and comment number 125 from a 28 year old A-4/F-16 pilot: "Make this a 4 year qualification - like swimming. That

would cover each sea tour." Several aircrew on the other hand, indicated it should be a one time training experience. Aircrew comments concerning exactly when the training should be given revealed they thought it should be for all fighter-attack aviators and should be given very early in their training: comment number 211 from a 26 year old F-18 pilot: "Super training - recommend training all the way down to training command level"; comment number 242 from a 26 year old F/A-18 pilot: "Super training! Probably need to have this training just prior to RAG/FRS training"; comment number 250 from a 34 year old TA-4/F-14 pilot: "This is a great program - a must for all tactical aircrew"; and comment number 3 from a 27 year old AV-8B pilot: "Great program, think it should be employed by Naval Air in 3 phases: (1) In AI [Aircrew Indoctrination] just as with altitude chamber, (2) After selection to the jet pipeline, and (3) Prior to or just after completion of RAG." We strongly concur with these opinions and consider that even training command aircrew should receive the training since the highest number of G-LOC episodes occur at this stage of flying[6]. It also standardizes the training techniques and crystallizes the optimum AGSM from the start, integrating it into the multitude of flying skills that are required to be performed coincidentally. Several aviators referred to the "learning experience" as the best part of the program: comment number 65 from a 39 year old F-4E pilot: "Its a great idea to go through this training before flying an airplane that can do this to you"; and comment number 160 from a 29 year old F-4 pilot: "Going through training prior to flying a jet capable of this stress, establishes a good starting point and good habits."

Although the aircrew were very much in favor of the training for all fighter-attack aviators it appears they do not favor a pass/fail program: comment number 83 from a 35 year old F/A-18 pilot: "Should be a part of training track between basic and advanced jet. Keep non-washout criteria"; and comment number 182 from a 37 year old F-16 pilot: "The no-threat environment adds to the learning curve and honesty." We concur with these opinions and consider that there should be careful consideration of the difference between veteran fighter-attack aviators and undergraduate naval aviators when developing program "pass/fail" criteria.

The centrifuge training evidently provided a unique opportunity for a few aircrew to observe their performance following an evening of revelry: comment number 8 from a 28 year old F-14 pilot: "A lack of rest and excess 'drink' had a definite impact on my performance. Being able to experience that in a safe environment was a key learning experience"; and comment number 26 from a 26 year old F-14A+ pilot: "The learning experience. I found out what my performance is after a booming night on the town and no flights in the past two and one half weeks. It's too bad more of our aircrew don't have ready access to a training centrifuge to evaluate their performance in similar circumstances." Such observations by aircrew are powerful learning experiences and could serve as a basis of behavior modification to enhance safety and combat performance.

We have employed a computer assisted training device ("HOOK MASTER") to allow aviators to practice the timing of their AGSM prior to their training profiles at ground ($+1G_z$) level[7]. Many aircrew found this beneficial: comment number 229 from a 28 year old F/A-18 pilot: "G-practice computer was outstanding."

It should be noted that with aircrew exhibiting such favorable attitudes toward the training, it provides a very fertile environment to further enhance the fighter aviation medicine and physiology support bond with our aviators. Aviators were very receptive to such additional interactions: comment number 100 from a 40 year old F-18 pilot: "The entire program is great. We also got to look at some new flight gear - very interesting"; and comment number 113 from a very motivated 32 year old F-16 pilot: "The fleet <u>does not</u> get the impact of your research (8 month or 6 month cruise). There needs to be facilities for <u>aircrew</u> to exercise. Whatever bakerplates and broken equipment was available was inaccessible because of too many enlisted personnel or because facility was closed because senior chief doesn't want the new paint messed up. XO of ship needs to know this important stuff but who's going to tell him? CO? CAG? I doubt it! It is not important enough an issue. Conditioning is important for G-tolerance. There is <u>NO</u> program at all in the fleet! WHY NOT? FOR ACTION is not going to cut it.

Spending 100K-200K is not too much. We need an advocate!"

Several aircrew were quick to grasp the importance of physical conditioning relative to optimum performance in the high-G environment: comment number 70 from a 26 year old F-18 pilot: "It taught me how to improve/increase my G-tolerance, what my limits were, and that my legs need more squats"; and comment number 206 from a 32 year old F/A-18 pilot: "Tough! A lot harder than I expected but does give good idea of tolerance and need for weight training, etc." It is evident that when aircrew are convinced of the expertise and dedicated support provided by fighter aviation medicine and physiology, they are very receptive to a multitude of advanced interactions. At present they are evidently starving for more information and aeromedical support.

It was evident that many aviators who had negative preconceived notions about centrifuge training reversed their opinion following completion of the program: comment number 32 from a 38 year old A-7E pilot: "Superb program - I didn't want to participate in the program but now I've had the training I am glad and I can see how useful it is"; and comment number 175 from a 29 year old F-4 pilot: "I had no idea what a great training aid this is." The goodness of the centrifuge training must also be weighed in light of a large number of aircrew who had to overcome difficult travel and billeting arrangements just to arrive at NADC for the training. Relying on available airlift and living in less than satisfactory quarters prior to the morning of the training was completely overshadowed by the benefits of the training experience. This makes the favorable critiques even more impressive.

We consider the aircrew training of extreme importance and, based on the very favorable critiques, are totally committed to the most rapid training of all tactical aircrew. Our enthusiasm and sense of urgency is shared by many of the veteran aviators: comment number 16 from a 27 year old A-7E: "Get more funding to make program available for all individuals in squadron"; comment number 34 from a 40 year old A-7E squadron commander: "Terrific program - I intend for all my pilots to attend as soon

as possible"; comment number 218 from a 27 year old F/A-18 pilot: "I learned more today than in the past 5 years about my own ability to perform in the high G arena. This program is super - why are we just now getting it?"; comment number 215 from a 31 year old F/A-18 pilot: "Long overdue - should have had this training years ago. A must for all TACAIR pilots"; and comment number 297 from a 33 year old A-10 pilot: "Train all our pilots - NOW!!"

DISCUSSION

Based on the aviator opinions concerning what they considered the most important parts of the high-G training program, it is possible to make significant improvements on what is evidently already an outstanding program. The major objectives of the program remain unchanged as previously articulated[1] and broadly include enhancing flight safety and combat capability. Specific enhancement of the program can be achieved in various areas as grouped in Table I. The points discussed in this report do not address all of the major changes recommended by the aviators. These will be discussed in a subsequent report. The following represent only possible improvements that can be made to strengthen the facets of the program that aviators considered most important.

It is evident that the aviators view the entire program as a coordinated effort and many recommend no changes whatsoever. The combination of G-awareness briefing, individual AGSM coaching, the centrifuge runs, and post-run videotape debriefing represent an extremely effective training program. Alterations of the current program must be pursued aggressively but with care since some aircrew answered the question concerning the most important part of the program with not wanting any changes whatsoever: comment number 77 from a 27 year old F-14 RIO: "Great program -don't change"; comment number 298 from a 29 year old F-4 pilot: "It works like a well-oiled clock - don't let anyone muck it up!"; and comment number 294 from a 33 year old A-10 pilot: "Keep as is! Don't let someone spoil it."

Aviators considered the training valuable as a confidence builder and an aid to enhance combat capability. They were very interested in knowing their tolerance to $+G_z$-stress and their personal limits. The demonstration of being able to successfully tolerate $+9G_z$ for 15 seconds was considered very valuable. Many aircrew evidently have never known how to perform an optimally effective AGSM, and not only learning how but seeing its effectiveness was very powerful. The majority of aviators were very much in favor of the "HOOK" maneuver. Based on our daily reviews of the program critiques we very early on developed a specific manuscript which described the "HOOK" maneuver[2]. It has many other valuable benefits as a training aid in the program as listed in Table II.

Almost every aspect of the training procedures and techniques were mentioned as important. The G-awareness brief and in particular the videotapes used were considered very beneficial and operationally important. The assignment of an individual AGSM coach to each trainee was received with much praise. The coach took them through AGSM practice before and during the centrifuge runs and the post-run debriefing with their videotape. It therefore becomes extremely important to have a highly trained and motivated coaching staff who are deeply involved in the program. The vast majority of aircrew considered watching their fellow classmates as critically important. It is therefore important to have the appropriate classroom environment for such interaction. We have concentrated all training information and responses on the video monitor/videotape for these reasons[3]. We strongly concur with the opinion of many aircrew that "G-LOC training" would be a very beneficial addition to the program[5]. It is considered extremely important in the aircrew centrifuge training program of other nations with high performance aircraft[10].

The motivation and credibility of the training personnel were important to aircrew and are unquestionably key to the success of any aircrew training program. Establishment of a strong working relationship between the training staff and aircrew ensures that the training is conducted in a safe and benign environment. Trust in the training faculty is vital. This is undoubtedly one reason why not even

a single naval aircrewman hesitated to have ECG monitoring during the training exposures. We consider the ECG monitoring an extremely important aspect of ensuring safety and performance during exposure to high $+G_z$[8]. For veteran aircrew we are not in favor of extremely selective tolerance standards that constitute a "pass/fail" program. If initiated in the early phases of aviator training more selective criteria may be acceptable.

Overall, it is clear that aircrew were convinced that the program was a very beneficial learning experience. It is therefore an ideal time to enhance the fighter aviation medicine and physiology interface with the fighter aircrew we strive to serve. Although nothing must be allowed to detract from the primary objectives of the acceleration training, a carefully integrated plan to demonstrate advanced research and development efforts to aircrew is well within the scope of the training program. We in fighter aviation medicine may never again have such a fertile opportunity to gain the full confidence of our aviator clientele. Included in Appendix III is a report written by a USMC squadron commander following completion of the NADC centrifuge training[9]. It is therefore evident that the NADC program is making an important impact on operational aviators if it is powerful enough to motivate such individuals to write such articles.

CONCLUSION

The critiques from fighter-attack aviators who have participated in high-G centrifuge training at NADC have been very gratifying and encourage us to continually update the program in accordance with the desires of the clientele we directly support. It is evident that the aircrew strongly support the concepts and techniques currently employed. Specific changes have been advocated by these aviators and they will be further addressed in a separate report. The comments concerning what the aviators considered the best part of the program are very important. They define the aspects of the program that should be emphasized and further refined. Based on responses from this initial open-ended question critique

following training of 525 aviators, a second generation critique to more thoroughly explore specific techniques and procedures has been implemented. It is important to review the aviator critiques both daily and at periodic intervals. Together with the verbal opinions expressed during the training which can be obtained by close interaction with each class, the most rapid program modifications can be interjected to keep the program in-step with what will provide optimum support.

We have listed in Appendix II every comment that could provide insight into techniques and procedures that were important or could possibly be modified. The only comments not included were those which simply stated the program "as is" was exactly what they wanted. There were no negative or hostile overall comments received from any USN, USMC, or USAF aircrew. There was only a single negative comment to any specific question on any of the critiques returned to us. That comment specifically referred to the overall cost of the funding to use the NADC facility and not directly to the training program. The single negative comment was from a 40 year old F/A-18 pilot: "Good, but a tremendous waste of money at 30K/week, 30K=30+ sorties in the F/A-18." We concur with this comment completely and feel strongly that based on aviator opinion of the benefits of the program it should not be funded directly by each squadron but should be fiscally managed in the same manner as the remainder of physiological training in aviation. For fighter-attack aviators, this training may be the most important mission specific physiological training that exists, and should be funded accordingly. The training not only enhances flight safety, as does other types of physiological training, it also directly improves combat effectiveness and weapon system utilization. Overall combat readiness and safety remain degraded every day that we have less than 100% of our fighter-attack aviators who have yet to

complete high-G centrifuge training. It is evident that the aircrew themselves concur with this opinion as evidenced by their critiques.

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TABLE I. FOUR MAJOR CATEGORIES OF RESPONSES CONCERNING THE ASPECTS OF THE TRAINING PROGRAM THAT FIGHTER AIRCREW CONSIDERED MOST BENEFICIAL.

I. ALL OF IT

II. ENHANCED PERFORMANCE/CAPABILITY

- A. ANTI-G STRAINING MANEUVER (AGSM), SPECIFICALLY THE "HOOK" MANEUVER
- B. ENHANCED COMBAT CAPABILITY
- C. CONFIDENCE BUILDER (TOLERATING +9G_z)
- D. G-AWARENESS
- E. KNOWLEDGE OF PERSONAL TOLERANCE/LIMITS

III. TRAINING PROCEDURES/TECHNIQUES

- A. BRIEFING AND VIDEOTAPES
- B. AGSM TIMING PRACTICE COMPUTER
- C. COACHING
- D. CENTRIFUGE RUNS
- E. DEBRIEFING AND VIDEOTAPE
- F. OBSERVING OTHER TRAINEES
- G. G-LOC EXPOSURE

IV. OTHER

- A. TRAINING PERSONNEL
- B. SAFE ENVIRONMENT FOR HIGH-G EXPOSURE
- C. MEDICAL MONITORING
- D. BENIGN TRAINING ENVIRONMENT
- E. "LEARNING EXPERIENCE"
- F. ADDITIONAL AEROMEDICAL INFORMATION

TABLE II. BENEFITS OF THE "HOOK" MANEUVER

1. "HOOK" IS HOW YOU DO IT
2. EASY TO TEACH/DEMONSTRATE
3. EASY TO REMEMBER BY AIRCREW
4. EASY TO OBSERVE AND CRITIQUE
5. EASY TO STANDARDIZE
6. EASILY AUDIBLE ON FLIGHT RECORDINGS
7. EMPHASIZES COMPLETELY CLOSED GLOTTIS
8. REDUCES CONFUSION
9. PROVEN EFFECTIVENESS
10. PROVEN AIRCREW ACCEPTABILITY

APPENDIX I

G-TIP CRITIQUE

APPENDIX I: G-TIP CRITIQUE

YOUR INPUT IS EXTREMELY IMPORTANT TO HELP IMPROVE G-TIP. YOUR COMMENTS WILL HELP THE NEXT GROUP OF AVIATORS AND WILL SERVE TO SHAPE THE FINAL G-TIP PROGRAM WHEN A DEDICATED TRAINING FACILITY IS COMPLETED. FAVORABLE COMMENTS ARE AS IMPORTANT AND HELPFUL AS CRITICISMS - PLEASE HELP US TO IMPROVE OUR PROGRAM FOR YOU! THANK YOU!!!!!!

1. COMMENTS ON TRAVEL, QUARTERS, AND TRANSPORTATION:

2. COMMENTS ON "G" AWARENESS BRIEFING:

3. COMMENTS ON CENTRIFUGE TRAINING:

4. COMMENTS ON FACILITIES:

5. COMMENTS ON PERSONNEL:

6. WHAT WAS THE BEST PART OF THE G-TIP PROGRAM (IF ANY)?

7. WHAT CAN WE CHANGE TO BETTER SERVE YOU?

8. GENERAL COMMENTS:

IN ORDER TO COMPARE YOUR NEEDED COMMENTS WITH OTHER AVIATORS, WE ASK THAT YOU FILL OUT THE FOLLOWING AND ADD ANY FURTHER COMMENTS THAT YOU FEEL ARE IMPORTANT TO THIS PROGRAM.

AGE: AVIATION STATUS: (PILOT, RIO, NFO) CURRENT A/C:

DISPLAY QUALITY

DID THE DISPLAY EXHIBIT ANY CHARACTERISTICS DETRIMENTAL TO THE TRAINING? (I.E., FLICKER, NOISE, INADEQUATE RESOLUTION, SMALL FIELD OF VIEW)

THE DISPLAY IN THIS TRAINING WAS A REAL IMAGE LOCATED ON A CRT SCREEN. IT DOES NOT PROVIDE THE DEPTH PERCEPTION CUES OF A VIRTUAL IMAGE DISPLAY SYSTEM USED ON MOST FLIGHT TRAINERS. WOULD A VIRTUAL IMAGE DISPLAY SYSTEM ADD TO THE EFFECTIVENESS OF THIS TRAINING? (PLEASE RESPOND BY COMPARING A PARTICULAR FLIGHT TRAINER WHERE POSSIBLE.)

APPENDIX II

AIRCREW RESPONSES TO CRITIQUE
QUESTION: "WHAT WAS THE BEST PART OF G-TIP?"

APPENDIX II. AIRCREW RESPONSES TO CRITIQUE QUESTION:
"WHAT WAS THE BEST PART OF G-TIP?"

COMMENT NUMBER	AGE (YRS)	AVIATOR STATUS*2	AIRCRAFT	COMMENTS*1
1.	25		F-14	Exceptional program. All TAC fighter crews should benefit from this.
2.	25	NFO	F-14	Outstanding program. Should be implemented throughout the fleet.
3.	27		AV-8B	Great program, think it should be employed by Naval Air in 3 phases: (1) In AI just as with altitude chamber (2) After selection to jet pipeline (3) Prior to or just after completion of RAG.
4.	43		F-4E	Tremendous opportunity to experience personal limits and then improve/increase them with appropriate coaching/training.
5.	32		F-16	Best training I've ever had! Will increase my ability to kill enemies of the U.S. I can use my aircraft capability fully now!
6.	26		F-14A	I believe it should be a "must" for everyone. I was able to see exactly the advantages of using the hook (3 sec on - 1 sec off). Great hands on training.
7.	28		F-14	Really appreciated misc. info pertaining to TACAIR after run, i.e., Spatial disorientation, mid-air collisions, etc.
8.	28		F-14	A lack of rest and excess "drink" had a definite impact on my performance. Being able to experience that in a safe environment was a key learning experience.
9.	28		F-16/A-4	Being able to recognize the onset of G-LOC.
10.	28		F-16/A-4	This kind of training is probably long overdue in the Navy. G-LOC is a problem that must be recognized and dealt with accordingly.
11.	27	RIO	F-14	Feeling 9G's and knowing you can hack it.

COMMENT NUMBER	AGE (YRS)	AVIATOR STATUS	AIRCRAFT	COMMENTS
12.	28	RIO	F-14	I was always under the impression that once you started to grey out that you could not regain vision without easing the G. Now I know that if I HOOK harder I can push it back.
13.	39		F-15	This is the first time in 17 years of flying fighters I've correctly performed the AGSM.
14.	26		F-14	Fantastic program. We need a centrifuge at every base for constant use by aircrew. This training is a must on a regular basis.
15.	27		A-7E	Simulator and watching other individuals methods for G-tolerance build up.
16.	27		A-7E	Get more funding to make program available for all individuals in squadron.
17.	26		F-18	Watching our flight doc puke.
18.	42		F/A-18	The ride. Class "E" Disneyworld ride.
19.	29		A-7	Realistic confidence builder.
20.	28		F/A-18	The ride closely followed by the lecture. One of, if not the best programs I have ever attended.
21.	25		F/A-18	The G-LOC experience.
22.	26		A-7E	Improving the pilot's awareness of G-LOC.
23.	27		A-7E	Hands-on training the best.
24.	25		F-14	Excellent, can't say enough on how effective hands-on instruction is.
25.	24		F-14	GOR was really informative and 6G x 30 sec. excellent practice.
26.	26		F-14A+	THE LEARNING EXPERIENCE. I found out what my performance is after a booming night on the town and no flights in the past 2.5 weeks.
27.	31		F-16/A-4	This is the place to pull 9G's for 15 seconds and not in a jet for the first time. Being an adversary pilot flying F-16N's I may find myself in a situation like this and having seen the sustained G loads in the centrifuge is invaluable.
28.	28	NFO	F-16/A-4	Watching video with debrief.
29.	24		F/A-18	Being able to put things I was taught to use immediately.

COMMENT NUMBER	AGE (YRS)	AVIATOR STATUS	AIRCRAFT	COMMENTS
30.	39		A-7	Actual practice of the HOOK maneuver with video debrief to see what weakness existed and how to improve it.
31.	39		A-7	Painful, exhausting and definitely worthwhile - a man has to know his limitations.
32.	38		A-7E	Superb program - I didn't want to participate in the program but now I've had the training I am glad and I can see how useful it is.
33.	29		A-7E	The HOOK and the symptoms of G-LOC.
34.	40		A-7E	Terrific program - I intend for all my pilots to attend as soon as possible.
35.	28		A/4-F-16	The high G profiles 8-9G. Great hands-on experience.
36.	38		F-16N	Lecture was great but even better was the actual run in the centrifuge. An invaluable learning and training experience! Not to be missed by "Aerospace Athletes."
37.	48		F-5	Seeing my mistakes - I've been doing it wrong! Very impressed - you are directly enhancing our safety.
38.	28		F-14	Finding out what your tolerance is.
39.	26	NFO	F-14	Gradual onset with no G-suit to show limits.
40.	34		F-14	Coaching in centrifuge.
41.	41		F/A-18	The ride (but only once).
42.	41		F-18	Best, most worthwhile aviation physiology training I've had in 20 years, a must for TACAIR.
43.	33		F-18	Confidence about personal limits.
44.	29		AV-8B	Brief on technique (makes profile accomplishment successful).
45.	28		F-14	Very valuable training. Learned things about personal tolerance never possible anywhere else.
46.	25		F-14A	Being able to test your limits, improve your strain, and test it out on the spot.
47.	26		F-14	Definitely, I now know how to really fight G-LOC; I'm confident of my abilities now.
48.	28	FS		The relaxed, confident atmosphere I sensed while in the ball.

COMMENT NUMBER	AGE (YRS)	AVIATOR STATUS	AIRCRAFT	COMMENTS
49.	31		A-4/F-16	Losing consciousness and not knowing it. Too bad you can't take every aviator to G-LOC.
50.			A-4/F-16	Unbelieveable. Everyone should do it prior to F-16 flight.
51.	30		A-4/F-16	Passing out.... I maximized my training opportunities.
52.	25		F/A-18	Fantastic training, everyone in the tactical communities should go.
53.	31		F-16/A-4	The 1 on 1 continual feedback during the centrifuge training. Super personnel!
54.	25		F-18	Extremely useful training - emphasis on the "HOOK."
55.	28		A-7E	Learning my limits and improving my hook procedure.
56.	28		A-7E	Brief and centrifuge ride.
57.	24		F-18	This training will give me more confidence to fly aggressively and safely.
58.	36		F-14	HOOK maneuver.
59.	31		F-4E	The knowledge and chance to practice maneuver with proper supervision.
60.	39		F-16	Awareness of effect of G-onset rates, and practice on AGSM.
61.	39		F4E	Training was held in a friendly and informative environment.
62.	29		A-10	People running the program.
63.	40		F-4E	The knowledge that you can tolerate the high G.
64.	39		F-4E	Actually practicing the proper straining maneuver under G and then observing it in debrief.
65.	39		F-4E	It's a great idea to go through this training before flying an airplane that can do this to you.
66.	26		F-14A	The little red stop run button.
67.	31		F-14	The girls at Double Vision (only kidding) - Seriously, the coaching during the runs definitely helped to improve technique and point out errors.
68.	35		F-14	Demonstration of the effectiveness of the proper HOOK.
69.	25		F-14	The debrief of the run - you can see your results.

COMMENT NUMBER	AGE (YRS)	AVIATOR STATUS	AIRCRAFT	COMMENTS
70.	26		F-18	It taught me how to improve/ increase my G-tolerance, what my limits were, and that my legs need more squats.
71.	26		F-14	G-LOC should be experienced by everyone.
72.	43		F-4E	Make training an annual or semi-annual requirement.
73.	26		AV-8B	It might be a good idea to go ahead and bring everyone to the point of G-LOC.
74.	28		F/A-18	I wish I would have had G-TIP before getting to my fleet squadron.
75.	30		F/A-18	Outstanding!! The only real opportunity to see the effectiveness of the AGSM. Well worth the effort!
76.	25		F-14	Outstanding. The chance to practice AGSM with no distractions and an accurate debrief.
77.	27	RIO	F-14A	Great program - don't change.
78.	28		F-14	Great learning experience.
79.	36		F-14A+	Don't think this is necessary to do more than once.
80.	30		F/A-18	Good looking secretary at front door. Great job overall.
81.	27		F/A-18	The centrifuge is an awesome tool for training. It sure beats the heck out of learning about G-LOC on the low altitude training route or in a ACM engagement! It is an absolute must for all high performance aircraft pilots.
82.	28		A-7E	The abdominal bladder on the G-suit extends too far up on my rib cage - hard to breathe. Upper zipper blew out on 8G run - then on 9G run it was much easier.
83.	35		F/A-18	Should be a part of training track between basic and advanced jet. Keep non-washout criteria.
84.	27		F/A-18	Really good! It taught me to be careful with the "I can hack it" attitude, plus how to recognize a G-LOC that's coming on (I had 2 G-LOC's). Keep doing business like you are, I'm a happy customer.
85.	41		A-37	"HOOK" much, much better than old "grunt" we were taught.

COMMENT NUMBER	AGE (YRS)	AVIATOR STATUS	AIRCRAFT	COMMENTS
86.	26		F-14	The recognition of G-LOC (this requires you to go to G-LOC) and the debrief.
87.	26		F-14	Good videotapes that brought the point home.
88.	24		F-14D	Outstanding training, especially the G-LOC experience, which is something everyone should experience at least once.
89.	43		F-4E	Probably the most valuable training I've received since pilot training.
90.	43		F-4E	Practicing the HOOK with immediate and direct response to doing it properly or improperly.
91.	26		AV-8B	Just outstanding for helping pilots avoid G-LOC. I will now be able to recognize/avoid G-LOC (I G-LOC'd once).
92.	24		AV-8B	The 1st ride to test G-tolerance threshold.
93.	28		F-18	The coaches and debrief.
94.	27		F/A-18	Being placed in the no kidding high-G environment and learning one's limits without finding out the hard way in the aircraft.
95.	24		F/A-18	The personnel running the program are the best part. Medicine and physiology are actually real helpful!
96.	27		F-18	Being able to see other people in the group helps you get it right.
97.	38		A-7E	Centrifuge ride, medical recording and video debrief were the most valuable part of the training.
98.	38		F-4E	"The ball" nobody should fly high G aircraft without this training.
99.	25		F-14	The educational benefits of learning a proper AGSM.
100.	40		F-18	The entire program is great. We also got to look at some new flight gear - very interesting.
101.	37		A-7E	The program as is, is very, very good. Change nothing.
102.	37		A-7E	The slow onset of G on the first run was very beneficial, even though the most painful and longest time spent at G.
103.	37		A-7E	On the 1st 9G run my vision started to go so I hooked harder and got it back - GOOD TRAINING!!

COMMENT NUMBER	AGE (YRS)	AVIATOR STATUS	AIRCRAFT	COMMENTS
104.	37		A-7E	I didn't know how to do the AGSM in spite of previous physiologic training courses. I know now!!
105.	41		F/A-18	Doing it in a benign environment. Not particularly fun, but outstanding, valuable training.
106.	26		F-18	All of it.
107.	30		F-14	Eye opening training. It changed a lot of attitudes.
108.	24		F/A-18	The physiology is much more effective knowing we could verify it immediately on the centrifuge.
109.	28		F-14	The centrifuge. Really lets you know what you need to improve for a good anti-G maneuver.
110.	28		F-14	Experiencing G-LOC.
111.	24		F-14	The debrief - seeing my own traces and realizing mistakes.
112.	27		F-18	The debrief after my 2 G-LOC's - explained what happened and why.
113.	32		F-16	The fleet does not get the impact of your research (8 month or 6 month cruise). There needs to be facilities for aircrew to exercise. Whatever bakerplates and broken equipment was available was inaccessible because of too many enlisted personnel or because facility was closed because senior chief doesn't want the new paint messed up. XO of ship needs to know this is important stuff but who's going to tell him? CO? CAG? I doubt it! It is not important enough an issue. Conditioning is important for G-tolerance. There is NO program at all in the fleet! WHY NOT? FOR ACTION is not going to cut it. Spending 100K - 200K is not too much. We need an advocate!

COMMENT NUMBER	AGE (YRS)	AVIATOR STATUS	AIRCRAFT	COMMENTS
114.	38		A-7E	This training should be completed by all tactical jet aviators at least. Suggest flight students be given at least a version of this training. A new student will probably have almost non-existent g-tolerance. To take him/her to 8-9G may be overwhelming. Perhaps, g-training with environment to 5-6G max. After a person builds flying experience and g tolerance, he/she should complete training as given today.
115.	38		A-7E	This training should be completed at least as often as physiology/ swimming training (every 4 yrs. currently).
116.	38		A-7E	Outstanding. This is the best g-environment type training I have ever had in almost 16 years of service. Doing AGSM in G-field is the only way to train.
117.	27		F-14	The training is a necessary evil.
118.	32		F/A-18	Very good training on AGSM (learning how to use it).
119.	32		F/A-18	Confidence builder. I had felt intimidated, since I've never pulled 9 G's before.
120.	23		F-14	Excellent training, very glad I got to attend, I learned a lot.
121.	25		F-14	A great asset to increase my awareness and ability in the aircraft.
122.	25		F-14	This training is invaluable to tactical aircrews.
123.	27		F-14	Good course. Highly recommend for all tactical pilots to attend.
124.	27		F-14	Induce G-LOC.
125.	28		A-4/F-16	Make this a 4 year qual. like swimming. That would cover each sea tour.
126.	23		F-14A	Excellent training - should be recurrent.
127.	35		A-7E	Necessary evil - safe way of experiencing limits.
128.	25		F-14	Need to have periodic refreshers.
129.	32		F-16	Learning tolerance levels.
130.	32		F-16	The experience is worth the time and money spent.

COMMENT NUMBER	AGE (YRS)	AVIATOR STATUS	AIRCRAFT	COMMENTS
131.	25		F/A-18	Very good. Painful but I can see the practicality. This is a real eye opener or should I say eye closer.
132.	29		AV-8B	The confidence builder is greater - tough but great.
133.	31	NFO	F-16	G-LOC for everyone.
134.	41		F-4	Excellent - best experience and actual simulation that I ever had.
135.	28		F-16/A-4/F-18	Outstanding training - should be mandatory for all fighter-strike fighter.
136.	35		A-4	Tolerating 9 G's.
137.	32		F-16	"Hook" training.
138.	33		F-14	Finding out relaxed G-tolerance. Seeing what 9 G's feels like.
139.	32		F/A-18	Learning the AGSM and how well it can work.
140.	29		F-14	Getting to do the hook and see the results.
141.	25		F-14	Finding out my personal G-limits.
142.	26		F-14	I particularly liked the first run, which demonstrated well the effectiveness of the AGSM.
143.	38		A-4/F-16	Got to practice/refine anti-G straining maneuver - can't do that in a jet (safely).
144.	28		A-4/F-16	Eye opening. Got as much watching others after finishing myself.
145.	26	Aerospace Physiologist		Realizing that this anti-G straining maneuver is so difficult and how important it is that the fleet be trained.
146.	25		F-14	Using the "hook" under G.
147.	25		F-14	Accomplishing the proper Hook maneuver.
148.	27	RIO	F-14	Learning your own limitations.
149.	24		F-14	Learning how to do the hook maneuver properly.
150.	26		AV-8B	Knowing my G-limits.
151.	25		F/A-18	The tape we get to take home and the experiences on it.
152.	29		A-7E	Watching the ugly faces.
153.	27		F-14	Active practice of the hook maneuver under G.
154.	26		A-7E	"You can come out now."
155.	40		F-16	Now I know I can do it if I have to.
156.	36		F-16	Awful - but mandatory for all TAC AIR.
157.	36		F-16	Helpful attitude of personnel.

COMMENT NUMBER	AGE (YRS)	AVIATOR STATUS	AIRCRAFT	COMMENTS
158.	30		F-16	Builds confidence in ability.
159.	35		F-15	Fine tuning my AGSM.
160.	29		F-4	Going through training prior to flying jet capable of this stress, establishes a good starting point and good habits.
161.	41		F-4	Truly outstanding - one of the few courses I've been thru where I exponentially increased my combat effectiveness. I didn't expect to learn as much as I did.
162.	30		F-4	The emphasis on training - NOT evaluation!
163.	28		F-14A	Good program - I got much more out of it then I thought it would.
164.	30		F-16	Brief/ball/debrief - all well done.
165.	24		F-14	The ride in the ball and watching others learn to hook correctly.
166.	26		F-14	Straining maneuver training and confidence building.
167.	32		F-16/A-4	Learning curve.
168.	34		F-14/F-16/ A-4	The videotape replay is great!
169.	26		F-14	Outstanding program (but once is enough).
170.	39		F-16/A-4	Now that I've done it, everyone should.
171.	32		A-4/F-16	Just the experience.
172.	35		A-4/F-16	The awareness brief.
173.	30		F-16	The brief and discussions with the pros.
174.	31		F-16/A-4	G-LOC.
175.	29		F-4	I had no idea what a great training aid this is.
176.	35		F-4	Effectiveness of a completely closed glottis.
177.	35		F-4	Once in lifetime ride.
178.	33		F-15	Videocritique.
179.	39		F-16	Verification that the straining maneuver works.
180.	46		F-4	9G over the shoulder.
181.	44		F-16	Everything excellent! One time only.
182.	37		F-16	The no threat environment adds to the learning curve and honesty.
183.	31		F-16	Experiencing G-onset during snatch to 8 and 9G.
184.	29		F-4	Hearing "You can get out now!"

COMMENT NUMBER	AGE (YRS)	AVIATOR STATUS	AIRCRAFT	COMMENTS
185.	34		F-16N/A-4	The lecture combined with the ride. The lecture in itself is outstanding, but the combination of the two is unbeatable.
186.	31		F/A-18	A healthy respect for G-LOC primarily the importance of leading G-onset with straining manuever.
187.	27		F/A-18	The awareness brief by the DOC and the post-run debrief.
188.	25		F/A-18	"HOOK" method and it worked great.
189.	29		F/A-18	Finally learned a good straining maneuver.
190.	29		F/A-18	Very good learning experience.
191.	35		F/A-18	Getting to work on the rapid onset of G-training is super.
192.	30		F/A-18	Lecture and ride. I never knew how incorrectly I was doing my straining maneuver until I had to do it!
193.	30		F/A-18	Excellent program - we need this!
194.	39		A-4/F-16	Experienced observers critiquing and improving my G-straining technique in an academic environment.
195.	25	NFO	F-14	The actual exposure to high "G's" goes beyond any lecture or instruction and being able to watch a replay afterwards is excellent.
196.	25	NFO	F-14	Great program - for the fighter community it should be done like water survival training with renewal dates, especially after a period away from flying.
197.	28		F-14A	Excellent - improved my AGSM and made me realize that I wasn't straining my legs. 9G's was easier than 8G's when I strained them also.
198.	26		F/A-18	Great! I felt my learning curve went way up with each run.
199.	27		F/A-18	Great! Coaching the Hook manuever BEFORE, DURING, and AFTER.
200.	35		F-16	Expertise of personnel.
201.	35		F-16	Viewing videotape prior to the rides.
202.	26	RIO	F-14A	Opportunity to experience G in a controlled, monitored environment.

COMMENT NUMBER	AGE (YRS)	AVIATOR STATUS	AIRCRAFT	COMMENTS
203.	41		F-14	The realization that I need to improve my technique and that I was able to go to 9G for 15 sec.
204.	28		A-7E	The ride was the first time I actually used an L-1/M-1 maneuver.
205.	30		F/A-18	Videotape debrief.
206.	32		F/A-18	Tough! A lot harder than I expected but does give good idea of tolerance and need for weight training, etc.
207.	28		F/A-18	Outstanding! Learned when I was on the edge, my limits, and what I need to do to improve them. Debrief was extremely beneficial.
208.	28		F/A-18	Geat program! Should be mandatory and annual.
209.	29		F/A-18	Coaching on HOO---KA, HOO---KA!
210.	27		A-7E	Pilot awareness of his own limitations and high G experience.
211.	26		F-18	Super training - recommend training all the way down to training command level.
212.	29		F/A-18	Super - you can talk all day about G-LOC/G-tolerance but this training demonstrates exceptionally well.
213.	29		F-16/A-4	Convince the Navy to go with Air Force G-suits; I've blown mine out twice on the rapid onset valve and both times had close call grey out.
214.	30		F-5/A-4	This training is invaluable. It helped me realize my limits and improve them.
215.	31		F/A-18	Long overdue - should have had this training years ago. A must for all TACAIR pilots.
216.	29		AV-8B	Best training program I've experienced in my flying career.
217.	27		F/A-18	You have a winner with this program.
218.	27		F/A-18	I learned more today than in the past 5 years about my own ability to perform in the high-G arena! This program is SUPER - why are we just now getting it?
219.	33		A-10	Top of the line training program. This will save lives and aircraft. A must for all TAC crews.

COMMENT NUMBER	AGE (YRS)	AVIATOR STATUS	AIRCRAFT	COMMENTS
220.	39		F-4E	I finally know how to do a good AGSM (after 14 years of flying jets)!
221.	28		F-14	I was fortunate enough to get behind on my straining and through "hooking" I got back up to speed. This training works. It is real time, true to life. I believe the most critical element of the hook maneuver is the timing. I believe a cadence tone would help to time the maneuver and assist in increasing efficiency. We already have enough things talking to us as it is, but I believe it is more important than a talking bingo, overtemp, etc.
222.	47		F-15	Discussion on the AGSM and then a chance to practice it.
223.	33		F-15	Teaching the "Hook" technique.
224.	31		F-15	The instructors.
225.	42		F-15	Mechanisms of a good AGSM.
226.	29		F-14A+	The experience of checking your limits and "slowly" getting some visual loss was very instructive.
227.	28	NFO	A-6	Feedback on my own personal G-limits.
228.	29		A-4/F-16	Learning the Hook maneuver.
229.	28		F/A-18	G-practice computer was outstanding.
230.	29		F-16/A-4	Getting to practive the "Hook" under G without the worry of losing a jet.
231.	29		F-16/A-4	"Hook" is easy to remember.
232.	31		F/A-18	Hook maneuver - it really works.
233.	29		AV-8B	Combination of briefing, AGSM practice, centrifuge rides, and debriefing is unbeatable.
234.	28		F/A-18	The end - good confidence builder.
235.	25		F/A-18	Enhanced understanding of AGSM.
236.	33		F/A-18	Emphasis on the "Hook" maneuver.
237.	25		F/A-18	9G's.
238.	29		F-4	Practicing AGSM in controlled environment and debrief.
239.	23	RIO	F-14	Watching everyone.
240.	27		AV-8B	Lecture and experiencing G-LOC.
241.	46		F-4E	This training will undoubtedly save lives and equipment.

COMMENT NUMBER	AGE (YRS)	AVIATOR STATUS	AIRCRAFT	COMMENTS
242.	26		F/A-18	Super training! Probably need to have this training just prior to RAG/FRS training.
243.	26		F/A-18	I can't emphasize the benefit this is to the TACAIR community.
244.	26		F/A-18	Centrifuge training should be given early in RAG training.
245.	28		F/A-18	Excellent training but most beneficial time would be during first couple of weeks into FRS/
246.	31		F/A-18	This is a great program - give earlier in training.
247.	31		A-6E	The best training and most useful training I've ever had (hated).
248.	41		A-7	Best aircrew training since pilot training.
249.	26		F/A-18	Definitely well worth the time - I have been using completely wrong technique before.
250.	34		TA-4/F-14	This is a great program - a must for all tactical aircrew.
251.	28		F/A-18	Invaluable for all TACAIR; should be required.
252.	27		---	This is the best training department of any kind in the Navy - the Ride.
253.	26		F/A-18	Excellent learning experience.
254.	25		F/A-18	One of the best training experiences I've had in my naval career. This program is invaluable.
255.	43		F-15	Should have opportunity to voluntarily repeat training one or two times per year.
256.	28	NFO	A-6	Should be a requirement for all pilots prior to FRS.
257.	29		A-4/F-16	Good program. Should train <u>all</u> aviators in RAG.
258.	29		A-4/F-16	Very worthwhile. I had a steep learning curve.
259.	34		F-15	The end.
260.	34		F-15	Academic review of tape following ride.
261.	37		A-10	The centrifuge ride. It was a great confidence builder.
262.	46		F-4E	The pain. I'm your basic masochist.
263.	26		F/A-18	The debrief and program format.

COMMENT NUMBER	AGE (YRS)	AVIATOR STATUS	AIRCRAFT	COMMENTS
264.	40		A-10	Ride itself the best - accompanied by a good one-on-one debrief.
265.	42		F-16	Very useful - even after 17 years flying fighters.
266.	42		F-16	The word and procedure --- "HOOK".
267.	31		A-6	Good critique of my anti-G hook maneuver.
268.	31		A-6	The ride.
269.	28		F/A-18	Furthering my awareness to the high-G environment.
270.	31		F/A-18	It provided a chance to actually perform and experience high-G in a controlled environment.
271.	31		A-6	Watching my fellow "saps" endureit.
272.	41		A-7	Learning to recognize and handle high sustained G.
273.	26		F/A-18	Perfecting the anti-G hook maneuver.
274.	34	RIO	TA-4/F-14	The debrief.
275.	50		A-7	Learning how to properly do the AGSM and seeing its subsequent effectiveness.
276.	28		F/A-18	Brief/debrief.
277.	32		F/A-18	One-on-one debrief post training.
278.	25		F/A-18	Helped me do an AGSM a hundred times better!
279.	38		F-15	"The Hook!"
280.	41		A-7	Experiencing the loss of consciousness helps give appreciation of importance of entire G-TIP program.
281.	43		F-15	Actual G-LOC training would be superb - could save lives.
282.	26	RIO	F-14	Blacking out completely with G-LOC (though embarassing) was good learning experience.
283.	48		A-7	Hook maneuver.
284.	43		A-7	Builds confidence as well as respect for high G.
285.	43		A-7	Coaches and debriefing.
286.	48		A-7	Very important for pilots to experience high "G" in this controlled environment. Also, it's a confidence builder.
287.	42		A-10	I really liked the "Hook" method.
288.	23		F-14	Coaching during training and debrief.
289.	37		A-6	I learned to refine my technique where I could vary my field of vision by regulating my lower body straining.

COMMENT NUMBER	AGE (YRS)	AVIATOR STATUS	AIRCRAFT	COMMENTS
290.	37		A-6	Incorporate this training program into FRS/CNATRA syllabus.
291.	23	NFO	F-14	All of it.
292.	34	WSO	F-4	Everything together.
293.	27		AV-8B	Lecture and experiences.
294.	33		A-10	Keep as is! Don't let someone spoil it.
295.	32		F-16	Nothing - keep on keeping on.
296.	43		F-4	My coach and the rest of the Navy team.
297.	33		A-10	Train all our pilots - NOW!
298.	29		F-4	It works like a well oiled clock - don't let anyone muck it up!
299.	29		F-4	Practice AGSM in controlled environment and debrief.
300.	34		F-4	All tactical aircrew must get this training - earlier the better. Should have had years ago. Sierra Hotel program!
301.	30		A-10	You're saving lives, money, and aircraft. Best example of joint service cooperation in existence.
302	25		F-14	In my opinion it is a good experience for pilots to experience higher G than they are used to experiencing.

* NOTE (1): These responses are all the responses other than the isolated expletives such as "tremendous, superb, great, etc." There were no negative comments. No screening of the comments other than that of leaving off the simple expletives was accomplished with this listing.

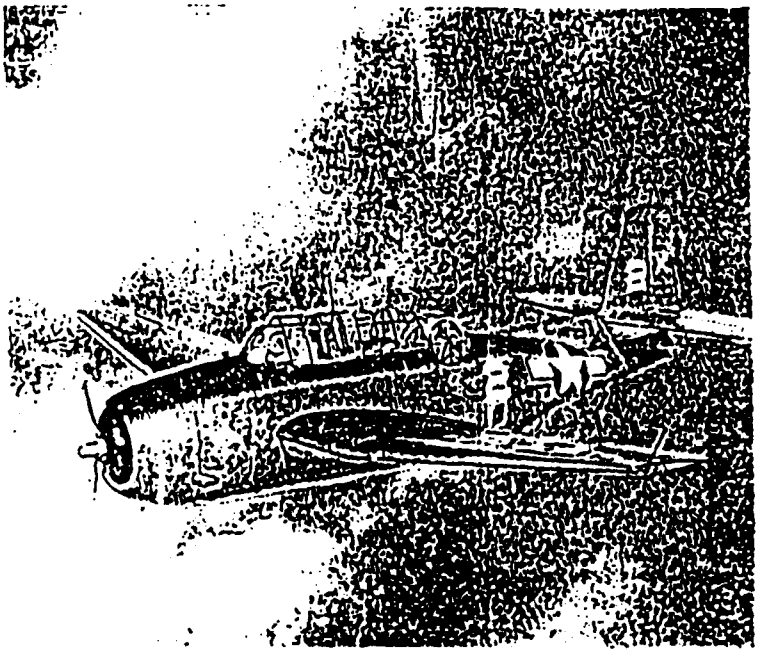
* NOTE (2): When "AVIATOR STATUS" is not listed it was from a pilot.

APPENDIX III

REPORT OF G-TIP TRAINING AT THE NAVAL AIR DEVELOPMENT CENTER
WRITTEN BY THE COMMANDING OFFICER, VMFA-22
(SEE REFERENCE NUMBER 9)

2D MARINE AIRCRAFT WING
MARINE CORPS AIR STATION
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THE HOT DOPE SHEET



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The Hot Dope Sheet is an internal publication of the 2d MAW for the purpose of creating operational excellence through standardization. The contents are informative rather than directive in nature. It is the goal of the publisher to create safety awareness throughout the Wing by providing timely education to aircrew and support personnel. The thoughts and principles contained within the Hot Dope Sheet should enlighten and challenge you to be the best at what you do. Contributions are encouraged as well as comments and criticism. Address all correspondence to Editor, Hot Dope Sheet, 2d MAW, Wing Safety, MCAS Cherry Point, NC 28533.

The next Hot Dope Sheet is scheduled for publishing in August 1990. If you would like to submit an article to the Editor, please feel free to contact us at 466-5832/3352 or Autovon 582-5832/3352.

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Remember, this flight configuration probably has not been flight tested.

- During the deceleration, do not slow to an airspeed where it would require more than one half stick or rudder deflection to maintain wings level flight. If airspeed is reduced beyond this point the pilot will greatly reduce his ability to counter uncommanded pitch, roll or yaw. An obvious unacceptable situation when trying to land.

- Lower the flaps to HALF. Most aircraft have optimum lift to drag conditions at half flaps. Drag greatly increases when the flaps are lowered from half to full, while only a small addition in lift is gained. A word of caution, lowering of the flaps may result in large pitch and/or roll excursions depending on the type and location of damage.

- Once the aircraft has been slowed to an airspeed at which a safe landing can be made do not go any slower. This is a point which many don't consider. There is absolutely nothing to be gained by reducing airspeed any further except a reduced stall margin and/or departure from controlled flight. Neither of which is desirable.

- Don't push it. If the aircraft is controllable 'minimally,' bring it back. However, if it isn't consider giving it back to the taxpayers (ejection seat or bailout capability). Make an honest evaluation at altitude. The time to find out that you made a bad decision is not at 100 feet AGL as you lose control and have the aircraft roll you out of the ejection envelope.

To summarize, there are numerous situations that require a controllability check of the aircraft. Since there is no formalized procedure, it is incumbent or individual aviators to have pre-thought-out gameplans to deal with controllability situations. The suggestions offered above are a starting point, nothing more.

"G-TIP: BASIC WARRIOR TRAINING FOR AVIATORS THAT CAN SAVE YOUR LIFE"

by LtCol R. A. Maddocks, Jr.
Commanding Officer
VMFA-251

Background

The relatively recent introduction of high performance Naval tactical jet aircraft such as the F/A-18 Hornet and F-16N Falcon, both of which possess performance envelopes that can exceed the aviator's physiological tolerance to G forces, compels us to evaluate squadron anti-G awareness training. The 1987 Joint Service G-Tolerance Conference, conducted in July of that year, produced a comprehensive review of the problem of G-induced loss of consciousness (G-LOC) and recommended a physical fitness program and other training to improve aircrew G tolerance. In 1988, Naval Air Development Command was chartered by the Chief of Naval Operations to develop academic and centrifuge training programs to fulfill the needs of the Navy and Marine Corps. This article will summarize the results of the Joint Service G-Tolerance

Conference and review the present NADC G-Training Improvement Program (G-TIP).

Problem

Joint G tolerance testing has concentrated on two primary but distinct areas of G tolerance based on G application rates, either gradual or rapid. Onset rates are particularly important to the aviator, as modern jet aircraft can produce G application rates in excess of 15 positive Gs per second. Studies have also shown that pilots can maintain useful consciousness, even with high G onset rates, from 5 to 7 seconds on the brain's oxygen reserve alone. This period of useful consciousness is, however, insidious, as the aviator will not receive normal physiological "cues" (E.g. grayout) prior to losing consciousness (Figure 1). Average total incapacitation after G-LOC can be 24 seconds or longer. During low onset rates, the physiological "cueing" process allows the pilot to recognize the onset of Gs and the normal cardiovascular reflexes to help increase arterial pressure to the brain. Of note, G onset rates less than approximately 1.5+ Gs/sec will normally produce cues.

The majority of Anti-G Training test subjects studied to date demonstrated relaxed positive G tolerance levels from 4.0 to 6.5 during gradual onset (.1+ G/sec) with no mechanical anti-G protection (i.e. anti-G suit). Figure 2 applies. The Joint Conference determined that aviators generally can withstand G forces equal to the performance of present aircraft with the help of mechanical and physiological countermeasures to maintain blood flow to the brain. With anti-G protection, a pilot also must use an appropriate anti-G straining maneuver (AGSM), essentially a "voluntary isometric contraction of the body's entire musculature and an increase of pressure within the chest by exhalation against a closed glottis."

All the experts agree that the safest and most effective anti-G training device is the centrifuge, and the NADC G-TIP uses a particularly worthwhile mix of academics and centrifuge training to achieve the following goals:

a. Increased knowledge of Physiologic Mechanisms of G Stress and G Tolerance

b. Recognition of G Stress Symptoms

c. Increased G Tolerance Skills

d. Increased Confidence in Sustaining High G Stress

As presented by Doctor Jim Whinnery, Chief Aeromedical Scientist at NADC, the benefits of this superb program are twofold; greater safety during air combat maneuvering and greater effectiveness (and increased survivability) in combat.

The Centrifuge
A Pilot's Perspective

Believe me, riding the NADC Centrifuge is an initially frightening experience. It is also the most useful and effective physiological training that I've received in twenty years of flying.

including combat. The device itself is formidable: a gimbal-mounted sphere suspended on a 50 foot moment arm, capable of producing in excess of 40 Gs. NADC engineers and specialists have produced a realistic cockpit environment that includes a visual display, ejection seat and pilot controls. The pilot is restrained using standard attachments to his torso harness and wears his issue anti-G garment. Additionally, the pilot wears dual EKG monitoring devices and a heart rate monitor. Two video cameras record the pilot's performance.

After initial academic instruction, pilots are assigned training coaches who review the centrifuge profiles, provide AGSM tips and coach the pilot during the runs. Other specialists, including qualified technicians, flight surgeons and physiologists monitor and record centrifuge and pilot performance. Each of these professionals is intent on achieving the training objectives previously identified.

High-G tolerance training profiles include one gradual-onset run and four rapid-onset runs (see Figure 3). The gradual-onset run commences at a low threshold, with no mechanical anti-G protection, and is used to determine the pilot's relaxed G tolerance and maximum straining tolerance up to 9 Gs. The pilot performs his AGSM beginning at his relaxed 'visual end point,' essentially when he loses peripheral colors on the visual display. His straining tolerance occurs when he again loses peripheral color or reaches the 9.0 G straining tolerance maximum. This run allows the pilot to determine not only his relaxed G-tolerance but also the relative increase provided by his AGSM. Since the run is relatively long (90 seconds), the pilot also experiences the effects of fatigue.

The four rapid-onset runs are considerably more challenging and reinforce the need to perform a pre-emptive AGSM. The first profile incorporates a rapid-onset to six Gs for a maximum period of 30 seconds. This particular run allows the pilot to practice his AGSM over a protracted period and 'fine tune' his straining maneuver.

The next two runs are to an 8.0 G and 9.0 G level, each for a period of 15 seconds. The pilot must work considerably harder and experiences even higher fatigue levels. The last profile is a 9.0 G profile in the 'check six' body position for ten seconds. Each of these challenging runs requires the aircrew to strain hard to the peak G and 'keep on top' through the remaining portion of the run.

The 'Hook' Maneuver

NADC has identified a clearly effective anti-G straining maneuver entitled the 'Hook.' By saying the word 'Hook,' the pilot voluntarily closes his glottis and increases blood column pressure in the chest. The AGSM effort is further enhanced by isometrically contracting the muscles of the body, particularly the abdomen and legs. A rapid air exchange is initiated at three second intervals. The 'Hook' is significantly more efficient than traditional L1/M1 AGSMs.

Physical Conditioning
to Improve G Tolerance

The Joint Conference also determined that anaerobic athletic conditioning improves G tolerance to a significant degree (see Figure 4). Specifically, high intensity events that require large muscle activity over a brief period are preferred (e.g. weight training and high speed sprints). This type of conditioning replicates the muscle activity experienced during air combat maneuvering where aircrews undergo high-G forces for short durations.

The 1987 Joint Service G-Tolerance Conference's report includes specific nutritional, life-style and muscular conditioning programs to increase G-Tolerance, and a maintenance program to use upon completing the 12-week conditioning effort.

Summary

High performance tactical aircraft require specialized aircrew training and conditioning for the sustained high-G environment. The NADC G-Training and Improvement Program, combined with the physical conditioning recommendations of the Joint Service Conference, provide an effective program to increase G-tolerance for greater safety during Air Combat Training and increased effectiveness in combat.

References:

1. Report of the 1987 Joint Service G-Tolerance Conference entitled 'Physical Fitness Program to Enhance Aircrew G Tolerance'. Naval Aerospace Medical Research Laboratory, NAS Pensacola, FL 32508-5700

2. 'G Training Improvement Program' Brief, Dr. James E. Whinnery, PhD, MAT, MD, Chief Aeromedical Scientist, NADC (Code 602C), Warminster, PA 18974

HYPOXIA - MERCILESS ENEMY

by Lt C. M. Lords (USN)
Aeromedical Safety O
MAG-31

Each year eight to ten hypoxia episodes are reported. Recently two hypoxia episodes ended in class 'A' mishaps. Both could have easily been avoided.

The first was a night flight for an A-6. The aircrew failed to comply with the general NATOPS (OPNAVINST 3710.7M, 814-3); which states, that aircrew of jet aircraft shall wear oxygen equipment from takeoff to landing. In this case the pilot removed his oxygen mask as soon as he had completed the clearing turn. The BN removed his mask after completing the radio transmissions (approximately 5000 ft). They were cleared to FL240. Minutes after leveling off the aircraft lost the right generator and subsequently experienced a total electrical failure. Whereupon the canopy opened slightly causing a rapid decompression. The BN turned on his oxygen supply and reconnected his mask. The pilot did not replace his mask, but began to trouble shoot the electrical failure and concentrated on getting the canopy closed. Consequently he became hypoxic and was

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